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cially Hatched Gulls,' and 'On Germinal Selection in Relation to Inheritance,' by Professor J. Arthur Thompson; 'The Tanganyika Problem,' by Mr. J. E. S. Moore; 'The Mechanism of the Frog's Tongue,' by Professor Marcus Hartog and Mr. Nevil Maskeleyne; 'Dimorphism in the Foraminifera,' by Mr. J. J. Lister; 'The Habits and Life Histories of some Sarawak Insects,' by Mr. R. Shelford; 'On a Large Nematode Parasite in the Sea-urchin,' by Dr. J. F. Gemmill; 'On the Youngest Known Larva of Polypterus,' by Mr. J. S. Budgett; on 'The Land Crabs of a Coral Island,' by Mr. L. A. Borradaile; and on 'The Fauna of an Atoll,' by Mr. C. F. Cooper.

A very pleasing incident of the meeting was the announcement of a generous gift, amounting to £3,500, from a donor who wished to remain anonymous, towards the equipment of the Scottish Marine Biological Station, now established at Millport on Cumbrae Island in the Firth of Clyde. The station, which was visited by a large number of the members of the Section, is admirably situated and is accomplishing most excellent work. The present gift will be devoted to an extension of the buildings so as to afford quarters for those who may be working at the station.

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ADDRESS OF THE PRESIDENT OF THE ANTHROPOLOGICAL SECTION OF THE BRITISH ASSOCIATION, II.

THE insular district in the fetal brain is a depressed area of an elongated triangular form. The general surface of the cerebrum occupies, all round about it, a more elevated plane, and thus the insula comes to be bounded by distinct walls, like the sides of a shallow pit dug out in the ground. The upper wall is formed by the lower margins of the frontal and parietal lobes, the lower wall by the upper margin of the

temporal lobe, and the front wall by the frontal lobe. From each of these bounding walls a separate portion of cerebral cortex grows, and these gradually creep over the surface of the insula so as to overlap it, and eventually completely cover it over and exclude it from the surface, in the same way that the lips overlap the teeth and gums. That which grows from above is called the *fronto-parietal operculum*, while that which grows from below is termed the *temporal operculum*. These appear very early, and are responsible for closing over more than the hinder three-fourths of the insula. The lower or temporal operculum is in the first instance more rapid in its growth than the upper or fronto-parietal operculum, and thus it comes about that when their margins meet more of the insula is covered by the former than by the latter. So far the development is apparently precisely similar to what occurs in the ape. The slit or fissure formed by the approximation of the margins of these two opercula is called the Sylvian fissure, and it constitutes a natural lower boundary for the parietal and frontal lobes which lie above it. At first, from the more energetic growth of the lower temporal operculum, this fissure slants very obliquely upward and backward, and is very similar in direction to the corresponding fissure in the brain of the ape. But in the human brain this condition is only temporary. Now begins that downward movement of the parietal lobe and back part of the frontal lobe to which reference has been made. The upper or fronto-parietal operculum, in the later stages of fetal life and the earlier months of infancy, enters into a growth antagonism with the lower or temporal operculum, and in this it proves the victor. The margins of the two opercula are tightly pressed together, and, slowly but surely, the fronto-parietal operculum gains ground, pressing down the temporal operculum, and thus extending

the territory of the frontal and parietal districts. This is a striking process in the brain development of man, and it results in a depression of the Sylvian fissure or the lower frontier line of the frontal and parietal lobes. Further, to judge from the oblique direction of the Sylvian fissure in the brain of the ape, the process is peculiar to man; in the simian brain there is no corresponding increase in the area of cerebral cortex under consideration.

I do not think that it is difficult to account for this important expansion of the cerebral surface. In the fore part of the region involved are placed the groups of motor centers which control the muscular movements of the more important parts of the body. These occupy a broad strip of the surface which stretches across the whole depth of the district concerned. Within this are the centers for the arm and hand, for the face, the mouth and the throat, and likewise, to some extent, the center for speech. In man certain of these have undoubtedly undergone marked expansion. The skilled movements of the hands, as shown in the use of tools, in writing, and so on, have not been acquired without an increase in the brain mechanism by which these are guided. So important, indeed, is the part played by the human hand as an agent of the mind, and so perfectly is it adjusted with reference to this office, that there are many who think that the first great start which man obtained on the path which has led to his higher development was given by the setting of the upper limb free from the duty of acting as an organ of support and locomotion. It is an old saying 'that man is the wisest of animals because of his hands.' Without endorsing to its full extent this view, I think that it cannot be a matter for surprise that the district of the cerebral cortex in man in which the arm-centers reside shows a manifest increase in its extent.

In the same region of cerebral cortex, but at a lower level, there are also situated the centers which are responsible for facial expression. In the ape there is a considerable degree of facial play; but this is chiefly confined to the region of the lips, and the muscles of the face, although present in greater mass, show comparatively little of the differentiation which is characteristic of the lighter and more feeble muscles in the face of man. And then as to the effect produced: These human muscles are capable of reflecting every fleeting emotion, every change of mind, and, by the lines and furrows their constant use indelibly fixes on the countenance, the character and disposition of an individual can to some extent be read. As the power of communication between primitive men became gradually established, facial movements were no doubt largely used, not only for the purpose of giving expression to simple emotions, such as anger or joy, but also for giving point and force to the faltering speech of our early progenitors by reflecting other conditions of mind. The acquisition of this power as well as the higher and more varied powers of vocalization must necessarily have been accompanied by an increase of cerebral cortex in the region under consideration. And in this connection it is a point well worthy of note that the area of cortex mapped out in the human brain,* as controlling the muscles of the face, mouth and throat, is as large if not larger than that allotted to the arm and hand,† and yet it is questionable if all the

* See diagram in Schäfer's article on the 'Cerebral Cortex' in his recent work on physiology.

† The comparison only refers to surface area, and this is not an absolutely true criterion of the relative amount of cortex in each region. The arm-center has a large amount of cortex stowed away within the fissure of Rolando, in the shape of interlocking gyri, which is not taken into account in a measurement confined to the superficial surface area. Still, this does not to any great degree detract from the argument which follows, seeing that the discrepancy is still sufficiently marked.

muscles under the sway of the former would weigh as much as one of the larger muscles (say the triceps) of the arm. This is sufficient to show that it is not muscle power which determines the extent of the motor areas in the cerebral cortex. It is the degree of refinement in the movements required, as well as the degree of variety in muscle combinations, which apparently determines the amount of ground covered by a motor center.

Still, the increase in the amount of cerebral cortex in man due to the greater refinement of movement acquired by different groups of muscles is relatively small in comparison with the increase which has occurred in other regions from which no motor fibers are sent out, and which therefore have no direct connection with muscles.

The remarkable conclusions arrived at by Flechsig, although not confirmed and accepted in all their details, have tended greatly to clear up much that was obscure in the relations of the different districts of cerebral cortex. More particularly has he been able to apportion out more accurately the different values to be attached to the several areas of the cerebral surface. He has shown that fully two thirds of the cortex in the human brain constitutes what he terms 'association centers.' Within these the higher intellectual manifestations of the brain have their origin, and judgment and memory have their seat. They are therefore to be regarded as the psychic centers of the cerebral cortex.

Now, it requires a very slight acquaintance with the cerebral surface to perceive that the great and leading peculiarity of the human brain is the wide extent of these higher association centers of Flechsig. Except in connection with new faculties, such as speech, there has been relatively no striking increase in the extent of the motor areas in man as compared with the cortex of the ape or the idiot, but the expansion of

the association areas is enormous, and the increase in the frontal region and the back part of the parietal region is particularly well marked. It is this parietal extension of surface which is chiefly responsible for the pushing down of the lower frontier of the parietal lobe and the consequent enlargement of its territory.

I have already referred to the views which have been recently urged by several independent observers, that in the men who have been distinguished during life by the possession of exceptional intellectual power this region has shown a very special development.

It is a curious circumstance, and one which is worthy of consideration, that in the left cerebral hemisphere the Sylvian fissure or the lower boundary of the parietal lobe is more depressed than in the right hemisphere, and, as a result of this, the surface area occupied by the parietal lobe is greater on the left side of the brain than on the right side. To the physiologist it is a matter of every-day knowledge that the left cerebral hemisphere shows in certain directions a marked functional preeminence. Through it the movements of the right arm and right side of the body are controlled and regulated. Within it is situated also the active speech center. This does not imply that there is no speech center on the right side, but simply that the left cerebral hemisphere has usurped the chief, if not the entire, control of this all-important function, and that from it are sent out the chief part, if not the whole, of the motor incitations which give rise to speech. The significance attached to the dominant power of the left hemisphere receives force from the now well-established fact that in left-handed individuals the speech function is also transferred over to the right side of the brain. To account for this functional preeminence of the left cerebral hemisphere numerous theories have been elaborated. The inter-

est attached to the subject is very considerable, but it is impossible on the present occasion to do more than indicate in the briefest manner the three views which have apparently had the widest influence in shaping opinion on this question. They are: (1) That the superiority of the left cerebral hemisphere is due to its greater weight and bulk; (2) that it may be accounted for by the greater complexity of the convolutions on the left brain and the fact that these make their appearance earlier on the left side than on the right side; (3) that the explanation lies in the fact that the left side of the brain enjoys greater advantages in regard to its blood supply than the right side.

Not one of these theories when closely looked into is found to possess the smallest degree of value. Braune* has shown in the most conclusive manner that if there is any difference in weight between the two hemispheres it is a difference in favor of the right and not of the left hemisphere; and I may add from my own observations that this is evident at all periods of growth and development. Equally untrustworthy are the views that have been put forward as to the superiority of the left hemisphere from the point of view of convolutionary development. I am aware that it is stated that in two or three cases where the brains of left-handed people have been examined this superiority was evident on the right hemisphere. This may have been so; I can only speak for the large percentage of those who are right-handed; and I have never been able to satisfy myself that either in the growing or fully developed brain is there any constant or marked superiority in this respect of the one side over the other; and I can corroborate Ecker† in his statement that there is no proof that the

convolutions appear earlier on the one side than on the other. The theory that an explanation is to be found in a more generous blood supply to the left hemisphere is more difficult to combat, because the amount of blood received by each side of the brain depends upon two factors, viz., the physical conditions under which the blood-stream is delivered to the two hemispheres and the caliber of the arteries or tubes of supply. Both of these conditions have been stated to be favorable to the left hemisphere. It is a matter of common anatomical knowledge that the supply pipes to the two sides of the brain are laid down somewhat differently, and that the angles of junction, etc., with the main pipe are not quite the same. Further, it is true that the blood-drains which lead away the blood from the brain are somewhat different on the two sides. Whether this would entail any marked difference in the blood-pressure on the two sides I am not prepared to say. This could only be proved experimentally; but, taking all the conditions into consideration, I am not inclined to attach much importance to the argument. It is easy to deal with the loose statements which have been made in regard to the size of leading supply pipe (viz., the internal carotid artery). It passes through a bony canal on the floor of the cranium on its way into the interior of the cranial box. Its size can therefore be accurately gauged by measuring the sectional area of this bony tunnel on each side. This I have done in twenty-three skulls chosen at random, and the result shows that considerable differences in this respect are to be found in different skulls. These discrepancies, however, are sometimes in favor of the one side and at other times in favor of the other side, and when the combined sectional area for all the skulls examined was calculated, it was, curiously enough, found to be $583\frac{1}{2}$ sq. mm. for the left side and 583 sq. mm. for the right side.

* 'Das Gewichtsverhältniss der rechten zur linken Hirnhälfte beim Menschen,' *Archiv für Anat.*

† *Archiv für Anthropologie*, 1868, Bd. CXI.

Leaving out of count the asymmetry in the arrangement of the convolutions in the two hemispheres, which cannot by any amount of ingenuity be twisted into such a form as to give a structural superiority to one side more than the other, the only marked difference which appears to possess any degree of constancy is the increase in the territory of the left parietal lobe produced by the more marked depression of its lower frontier line (Sylvian fissure). That this is in any way associated with right-handedness or with the localization of the active speech center in the left hemisphere I am not prepared to urge, because the same condition is present in the ape. It is true that some authorities* hold that the ape is right-handed as well as man, but in the gardens of the Royal Zoological Society of Ireland I have had a long and intimate experience of both anthropoid and lower apes, and I have never been able to satisfy myself that they show any decided preference for the use of one arm more than the other.

That differences do exist in the more intimate structural details of the two hemispheres, which give to the left its functional superiority, there cannot be a doubt; but these have still to be discovered. Bastian has stated that the gray cortex on the left side has a higher specific gravity, but this statement has not as yet received corroboration at the hands of other observers.

I have already mentioned that man's special endowment, the faculty of speech, is associated with striking changes in that part of the cerebral surface in which the motor center for articulate speech is located. It is questionable whether the acquisition of any other system of associated muscular movements has been accompanied by a more evident cortical change. The center in question is placed in the lower

and back part of the frontal lobe. We have seen that the insular district is covered over in the hinder three-fourths of its extent by the fronto-parietal and temporal opercula, and thus submerged below the surface and hidden from view. The brain of the ape and also of the microcephalic idiot with defective speech goes no further in its development. The front part of the insular district remains uncovered and exposed to view on the surface of the cerebrum. In man, however, two additional opercula grow out and ultimately cover over the fore part of the insula. These opercula belong to the lower and back part of the frontal lobe, and are to be looked upon as being more or less directly called into evidence in connection with the acquisition of articulate speech.

The active speech center is placed in the left cerebral hemisphere. We speak from the left side of the brain, and yet when the corresponding region* on the right side is examined it is found to go through the same developmental steps.

The stimulus which must have been given to general cerebral growth in the association areas by the gradual acquisition of speech can hardly be exaggerated.

During the whole course of his evolution there is no possession which man has contrived to acquire which has exercised a stronger influence on his higher development than the power of articulate speech. This priceless gift, 'the most human manifestation of humanity' (Huxley), was not obtained through the exertions of any one individual or group of individuals. It is the result of a slow process of natural growth, and there is no race, no matter how

* Rudinger and others have tried on very unsubstantial grounds to prove that there is a difference in this region on the two sides of the brain. There is, of course, as a rule, marked asymmetry; but I do not think that it can be said with truth that the cortical development of the region is greater on the left side than on the right.

* Ogle, 'On Dextral Preeminence,' *Trans. Med. Chirurg. Soc.*, 1871; Aimé Père, 'Les Courbures latérales normales au rachis humain,' Toulouse, 1900.

low, savage or uncultured, which does not possess the power of communicating its ideas by means of speech. "If in the present state of the world," says Charma, "some philosopher were to wonder how man ever began to build those houses, palaces, and vessels which we see around us, we should answer that these were not the things that man began with. The savage who first tied the branches of shrubs to make himself a shelter was not an architect, and he who first floated on the trunk of a tree was not the creator of navigation." And so it is with speech. Rude and imperfect in its beginnings, it has gradually been elaborated by the successive generations that have practiced it.

The manner in which the faculty of speech originally assumed shape in the early progenitors of man has been much discussed by philologists and psychologists, and there is little agreement on the subject. It is obvious that all the more intelligent animals share with man the power of giving expression to certain of the simpler conditions of mind both by vocal sounds and by bodily gestures. These vocal sounds are of the interjectional order, and are expressive of emotions or sensations. Thus the dog is said, as a result of its domestication, to have acquired the power of emitting four or five different tones, each indicative of a special mental condition and each fully understood by its companions. The common barn-door fowl has also been credited with from nine to twelve distinct vocal sounds, each of which is capable of a special interpretation by its fellows or its chickens. The gestures employed by the lower animals may in certain cases be facial, as expressed by the grimaces of a monkey, or changes in bodily attitude, as we see continually in the dog.

I think that it may not be unreasonably inferred that in the distant past the remote progenitors of man relied upon equally

lowly means of communicating with their fellows, and that it was from such humble beginnings that speech has been slowly evolved.

There cannot be a doubt that this method of communicating by vocal sounds, facial expressions and bodily gestures is capable of much elaboration; and, further, it is possible, as some hold, that it may have attained a considerable degree of perfection before articulate speech began to take form and gradually replace it. Much of it indeed remains with us to the present day. A shrug of the shoulders may be more eloquent than the most carefully prepared phrase; an appropriate expression of face, accompanied by a suitable ejaculation, may be more withering than a flood of invective. Captain Burton tells us of a tribe of North American Indians whose vocabulary is so scanty that they can hardly carry on a conversation in the dark. This and other facts have led Mr. Tylor, to whom we owe so much in connection with the early history of man, to remark: "The array of evidence in favor of the existence of tribes whose language is incomplete without the help of gesture-signs, even for things of ordinary import, is very remarkable"; and, further, "that this constitutes a telling argument in favor of the theory that gesture-language is the original utterance of mankind out of which speech has developed itself more or less fully among different tribes." It is a significant fact also, as the same author points out, that gesture-language is, to a large extent, the same all the world over.

Many of the words employed in early speech were undoubtedly formed, in the first instance, through the tendency of man to imitate the natural sounds he heard around him. To these sounds, with various modifications, was assigned a special conventional value, and they were then added to the growing vocabulary. By this means a very decided forward step was taken, and

now primitive man became capable of giving utterance to his perceptions by imitative sounds.

Max Müller, although bitterly opposed to the line of thought adopted by the 'Imitative School' of philologists, has expressed their views so well that I am tempted to use the words he employed in explaining what he satirically branded as the 'Bow-wow Theory.' He says: "It is supposed that man, being yet mute, heard the voices of the birds, dogs and cows, the roaring of the sea, the rustling of the forest, the murmur of the brook and the whisper of the breeze. He tried to imitate these sounds, and finding his mimicking cries useful as signs of the object from which they proceeded, he followed up the idea and elaborated language."

Hood* humorously and unconsciously illustrates this doctrine by a verse descriptive of an Englishman, ignorant of French, endeavoring to obtain a meal in France:

'Moo!' I cried for milk;
If I wanted bread
My jaws I set agoing;
And asked for new-laid eggs
By clapping hands and crowing.

But, although much of early articulate speech may have arisen by the development of interjectional sounds and the reproduction, by the human vocal organs, of natural sounds, it is very unlikely that these afforded the only sources from which words were originally derived. Romanes insists upon this, and, in support of his argument, refers to cases where children invent a language in which apparently imitative sounds take no part. He likewise alludes to the well-known fact that deaf mutes occasionally devise definite sounds which stand for the names of friends. In the light of such evidence, he very properly asks, 'Why should it be held impossible for primitive man to have done the same?'

* Quoted from 'The Origin of Language,' by Hensleigh Wedgwood, 1866.

The value of spoken language as an instrument of thought is universally admitted, and it is a matter incapable of contradiction that the higher intellectual efforts of man would be absolutely impossible were it not for the support which is afforded by articulate speech. Darwin expresses this well when he says: "A complex train of thought can no more be carried on without the aid of words, whether spoken or silent, than a long calculation without the use of figures or symbols." Such being the case, I think that we may conclude that the acquisition of speech has been a dominant factor in determining the high development of the human brain. Speech and mental activity go hand in hand. The one has reacted on the other. The mental effort required for the coining of a new word has been immediately followed by an increased possibility of further intellectual achievement through the additional range given to the mental powers by the enlarged vocabulary. The two processes, mutually supporting each other and leading to progress in the two directions, have unquestionably yielded the chief stimulus to brain development.

More than one philologist has insisted that 'language begins where interjection ends.' For my part, I would say that the first word uttered expressive of an external object marked a new era in the history of our early progenitors. At this point the simian or brute-like stage in their developmental career came to an end and the human dynasty endowed with all its intellectual possibilities began. This is no new thought. Romanes clearly states that in the absence of articulation he considers it improbable that man would have made much psychological advance upon the anthropoid ape, and in another place he remarks that 'a manlike creature became human by the power of speech.'

The period in the evolution of man at which this important step was taken is a

vexed question, and one in the solution of which we have little solid ground to go upon beyond the material changes produced in the brain and the consideration of the time that these might reasonably be supposed to take in their development.

Darwin was inclined to believe that articulate speech came at an early period in the history of the stem-form of man. Romanes gives a realistic picture of an individual decidedly superior to the anthropoid ape, but distinctly below the existing savages. This hypothetical form, half simian, half human, was, according to his sponsor, probably erect; he had arrived at the power of shaping flints as tools, and was a great adept at communicating with his fellows by gesture, vocal tones and facial grimaces.

With this accomplished ancestor in his mental eye, it is not surprising that Romanes was inclined to consider that articulate speech may have come at a later period than is generally supposed.

At the time that Romanes gave expression to these views he was not acquainted with the very marked structural peculiarities which distinguish the human brain in the region of the speech center. I do not refer to the development of the brain in other districts, because possibly Romanes might have held that the numerous accomplishments of his speechless ancestor might be sufficient to account for this; I merely allude to changes which may reasonably be held to have taken place in direct connection with the gradual acquisition of speech.

These structural characters constitute one of the leading peculiarities of the human cerebral cortex, and are totally absent in the brain of the anthropoid ape and of the speechless microcephalic idiot.

Further, it is significant that in certain anthropoid brains a slight advance in the same direction may occasionally be faintly

traced, whilst in certain human brains a distinct backward step is sometimes noticeable. The path which has led to this special development is thus in some measure delineated.

It is certain that these structural additions to the human brain are no recent acquisition by the stem-form of man, but are the result of a slow evolutionary growth—a growth which has been stimulated by the laborious efforts of countless generations to arrive at the perfect coordination of all the muscular factors which are called into play in the production of articulate speech.

Assuming that the acquisition of speech has afforded the chief stimulus to the general development of the brain, and thereby giving it a rank high above any other factor which has operated in the evolution of man, it would be wrong to lose sight of the fact that the first step in this upward movement must have been taken by the brain itself. Some cerebral variation—probably trifling and insignificant at the start, and yet pregnant with the most far-reaching possibilities—has in the stem-form of man contributed that condition which has rendered speech possible. This variation, strengthened and fostered by natural selection, has in the end led to the great double result of a large brain with wide and extensive association areas and articulate speech, the two results being brought about by the mutual reaction of the one process upon the other.

D. J. CUNNINGHAM.

*PROFESSOR PAWLOW'S RESEARCHES ON
THE PHYSIOLOGY OF SECRETION.*

THE publication, last year, of the conditions which are to govern the award of the Nobel prizes was followed not long since by the announcement that Professor J. P. Pawlow of St. Petersburg had been designated, with Professor Niels R. Finsen of Copenhagen, as the first recipient of this honor, for the most important discovery in